

Technical Data Package for a High-Energy X-Ray Linear Accelerator

NAVSEA Dahlgren will purchase a single high-energy x-ray linear accelerator through competitive procurement. The machine will be use for non-destructive radiographic inspection of ordnance, missile components and inert hardware at NAVSEA, Dahlgren Division.

The S-Band Dual Energy Linear Accelerator must be a modular system capable of operating at 6 MeV and 3.5 MeV. The Control Console, Modulator, and RF Unit must be common to all magnetron driven models commercially available from the equipment manufacturer. Only the x-ray head changes to match the application and energy. The system must be controlled using digital technology (PLC) controller with user interface capable of digital imaging. The x-ray head (linear accelerator) must use a drift tube and extended target with a leakage radiation level of 0.001 maximum of the primary beam, when measured along the horizontal axis outside of a 60° primary beam. This requirement is for safety and reduced radiation noise in digital imaging. The linear accelerator tube operating at S-band frequencies must be brazed and sealed at the Gun and Target. The magnetron must have an electromagnet capable of running in two levels for dual_energy capabilities of 6MeV and 3.5MeV. The system must use a closed loop temperature control unit that does not require water from facilities to cool. The equipment must be UL approved and be built to quality standards ISO 9001: 2000 certified.

DETAILED REQUIREMENTS

Control System

The control system shall use a programmable logic controller (PLC) to control and monitor all S-Band Dual Energy Linear Accelerator functions. The PLC shall allow for interface with the x-ray facility's safety interlock and warning system. The x-ray control system shall include an operator's control panel for setting x-ray parameters and monitoring system performance. The control system shall include the provision for an optional PC computer operator interface.

X-ray Beam Quality and Dose Rate

The X-ray beam quality is specified using Half Value Layer (HVL) in steel and corresponds to a nominal X-ray energy. The HVL quantities are derived from a compilation of broad beam data with a 10 cm x 10 cm field. The maximum continuous dose rate at 1 meter is listed as follows:

Model	Nominal Energy (MeV)	HVL (in)	Flatness (% @ ±7.5°)	Max. Dose Rate (Gy/min)
	3.5		0.96 ≥71.0	2.50
	6.0		1.10 ≥62.0	8.0

X-ray Field Size

A 22.5" square shall define the x-ray field.

X-ray Beam Focal Spot Size

The focal spot size shall not exceed 2.0 mm in diameter.

X-ray Beam Symmetry

The beam symmetry shall not exceed $\pm 5\%$ at $\pm 7.5^\circ$ off the central axis for all energies.

Leakage Radiation

The leakage radiation is measured at 1 meter from the beam centerline at angles 60° and greater, outside the primary beam. The following values are a fraction of the primary beam central axis dose rate measured along the horizontal axis with a 10 cm x 10 cm collimator. For energy of 6 MeV the maximum leakage is 0.001

Electrical Requirements

200-240 V, 3 phase Delta (4-wire) or Wye (5-wire) 80 Amp

Indoor Operating Environment

The control console and modulator shall operate in an environment between 4°C (39°F) and 35°C (95°F), with 90% maximum relative humidity (non-condensing).

Ventilation

The maximum heat given to room air from each component with system operating at full power is:

X-Ray Head: 1.0 kW

Modulator Cabinet: 2.0 kW

RF Unit: 1.0 kW

Dual Energy

The system shall contain the provision for dual energy operation of 3.5 MeV and 6 MeV. The energy level shall be selectable from the operator's console.

Laser Alignment System

The system shall contain an internally mounted single spot laser to align the X-ray beam to an object being radiographed. The laser dot shall be boresited with the center of the x-ray beam.

Temperature Control Unit (TCU)

A TCU shall be provided to maintain the operating temperature of the S-Band Dual Energy Linear Accelerator. The TCU shall be closed-loop with heat exchange to the air. The TCU shall be constructed for permanent mounting outdoors and shall operate with a maximum power draw of 25-kVA.

Radiographic quality

The S-Band Dual Energy Linear Accelerator system will demonstrate at least ASTM E 94 1-2T or equivalent sensitivity over the following range using film detection.

Model Nominal Energy 6.0 MeV
Range 51-254 mm of steel

Variable Collimator

The x-ray system shall have the provision for an external variable collimator with remote control and digital display. The external variable collimator shall be listed as an option in the supplier's technical proposal. The proposal shall address two options for purchasing the collimator. Option 1 is for purchase of the collimator with the x-ray machine. Option 2 is for any required x-ray machine modifications if the Government purchases the collimator in the future.

System Components and Dimensions

The x-ray head shall be no heavier than 2,500-lb with exterior dimensions no greater than 30-in wide, 48-in long and 48-in high. The control console shall be mountable in a standard 19-in electronics rack and shall occupy no more than 12-in of rack height. The modulator or electronics bay shall be no heavier than 1000-lb with exterior dimensions no greater than 48-in wide, 36-in deep and 60-in high

INSTALLATION

The seller shall install the system at NAVSEA, Dahlgren Division, Weapons Dynamics Branch, Pumpkin Neck Explosive Experimental Area. The Government will provide all interlock wiring, safety switches and warning devices. The seller's installation crew shall integrate these Government-provided circuits into the x-ray machine control system.

STANDARD COMPLIANCE

The seller must provide proof of compliance, conformance or certification with the following quality standards:

- a. Electromagnetic Compatibility Directive 89/336/EEC
- b. Low Voltage Directive 73/23/EEC
- c. UL STD 61010A-1
- d. CSA 1010.1
- e. Registered ISO 9001:2000 FM80701 by B.S.I.

REFERENCES

The supplier shall provide a list of references, preferably US government and military installations, that have taken delivery of the same equipments specified in this document.